Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Wednesday 5 June 2024

Afternoon (Time: 2 hours)

Paper reference **9BN0/01**

Biology A (Salters Nuffield)

Advanced

PAPER 1: The Natural Environment and Species Survival

You must have:
Calculator, HB pencil, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- **Show all your working out** in calculations and **include units** where appropriate.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Silver Springs is an ecosystem in Florida.

Energy flow through this ecosystem has been studied.

The value for the light energy entering this ecosystem is 7 112 800 kJ m^{-2} yr^{-1}.

The gross primary productivity (GPP) for this ecosystem is 87 069 kJ m^{-2} yr^{-1}.

The value for respiration (R) in this ecosystem is 55 195 kJ m^{-2} yr^{-1}.

(a) (i) Which of the following is the correct value for the net primary productivity (NPP) in this ecosystem?

(1)

☒ **A** 7 025 731 kJ m^{-2} yr^{-1}

☒ **B** 697 036 kJ m^{-2} yr^{-1}

☒ **C** 142 264 kJ m^{-2} yr^{-1}

☒ **D** 31 874 kJ m^{-2} yr^{-1}

(ii) The table shows some information on trophic levels in this ecosystem.

Trophic level	Energy intake / kJ m^{-2} yr^{-1}	Energy fixed as biomass / kJ m^{-2} yr^{-1}
Primary consumers	14 092	4 615
Secondary consumers	1 602	464
Tertiary consumers	88	21

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Calculate the percentage of the total light energy entering this ecosystem that is fixed as biomass in the primary consumers.

Give your answer to two significant figures.

(2)

.....%

(b) Describe the role of mineral ions in the production of plant biomass.

(3)

(Total for Question 1 = 6 marks)

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2 Anthropogenic activities are increasing levels of carbon dioxide in the atmosphere.

An increased level of carbon dioxide in the atmosphere leads to an increased rate of photosynthesis in some plants.

(a) Describe how carbon dioxide is used in photosynthesis.

(4)

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(b) The effect of increasing carbon dioxide concentration on photosynthesis in soya bean plants was investigated.

- Young soya bean plants were placed in six containers
- The air in each container had a different concentration of carbon dioxide
- After 34 days, samples of the leaves were weighed
- The mean dry mass per unit area of leaf was recorded

The table shows the result of this investigation.

Carbon dioxide concentration / ppm	Mean dry mass of leaves / g m^{-2}
160	20.3 ± 2.1
220	20.9 ± 1.7
280	21.4 ± 2.4
330	21.4 ± 2.4
660	26.6 ± 5.2
990	30.5 ± 5.2

(i) Which of the following describes the relationship between the increase in carbon dioxide concentration and the change in dry mass?

(1)

☒ **A** exponential

☒ **B** negative correlation

☒ **C** positive correlation

☒ **D** no correlation

(ii) The measurements were repeated at each concentration to calculate the mean and standard deviation.

Which of the following statements explains why this is carried out?

(1)

☒ **A** to carry out chi-squared analysis

☒ **B** to determine the repeatability of the measurements

☒ **C** to improve the accuracy of the measurements

☒ **D** to increase the validity of the measurements

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(c) Enzymes catalyse some of the reactions involved in photosynthesis.

Explain why an increase in carbon dioxide concentration above 1000 ppm may not increase the rate of photosynthesis.

(3)

(Total for Question 2 = 9 marks)

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3 New drugs are tested in clinical trials before they can be used in treatments on patients.

One of the first people to isolate and test a drug was William Withering.

(a) Give the name of the drug he tested.

(1)

.....

(b) Complete the table with a (✓) or a (✗) to show which of the stages that take place in contemporary drug trials were carried out by William Withering.

(2)

Procedure	Type of trial	
	William Withering	**Contemporary drug trial**
Use of a placebo		✓
Testing of dose		✓
Tested on healthy volunteers		✓
Double blind trial		✓

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(c) Paclitaxel is a drug used in the treatment of cancer.

Cancer involves cells dividing repeatedly in an uncontrolled manner.

Paclitaxel prevents spindle fibres from changing in length.

Deduce why Paclitaxel prevents cell division in cancer cells.

(3)

(Total for Question 3 = 6 marks)

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4 Cystic fibrosis is an inherited condition.

It is caused by mutations in the gene coding for the cystic fibrosis transmembrane conductance regulator (CFTR) protein.

Some of the mutations cause a change in the primary structure of the CFTR protein.

(a) Describe how a mutation can change the primary structure of a protein.

(3)

(b) (i) The CFTR protein is produced in cells of the lung and is involved in the transport of chloride ions.

Describe the location of the CFTR protein in the cell membrane of one of these cells.

(2)

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(ii) Describe how the CFTR protein is transported from the ribosome to the cell membrane.

(3)

(c) The most common mutation in the CFTR gene produces a protein that has the incorrect shape.

Explain why a change in the primary structure of a protein changes the three-dimensional (3D) structure of this protein.

(3)

(Total for Question 4 = 11 marks)

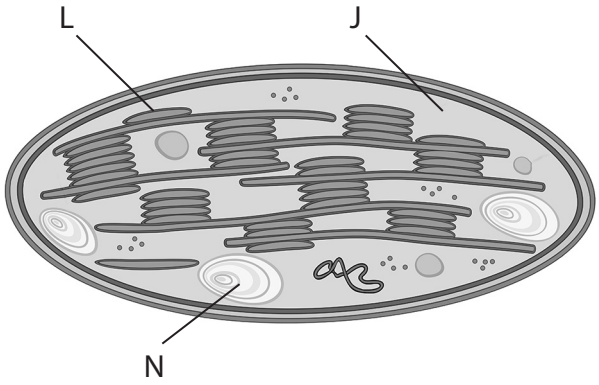
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5 Photosynthesis takes place in the chloroplast.

(a) The diagram shows the structure of a chloroplast with some parts labelled.



(Source: © Kazakova Maryia / Shutterstock)

(i) Which part of the chloroplast is labelled L?

(1)

- ☒ **A** a plasmid containing chloroplast DNA
- ☒ **B** the matrix where the Krebs cycle takes place
- ☒ **C** the stroma where the Calvin cycle takes place
- ☒ **D** the thylakoid where the light-dependent reactions take place

(ii) The part labelled J is

(1)

- ☒ **A** the matrix where the light-dependent reactions take place
- ☒ **B** the matrix where the light-independent reactions take place
- ☒ **C** the stroma where the light-dependent reactions take place
- ☒ **D** the stroma where the light-independent reactions take place

(iii) Which of the following is stored in the structure labelled N?

(1)

- ☒ **A** chlorophyll
- ☒ **B** glucose
- ☒ **C** lipid
- ☒ **D** starch

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(b) (i) Give the names of **two** products of the light-dependent reactions of photosynthesis.

(1)

(ii) The rate of light-dependent reactions can be measured in isolated chloroplasts.

Environmental temperature may affect the rate of these reactions.

Describe how DCPIP can be used to measure the effect of temperature on the rate of the light-dependent reactions in isolated chloroplasts.

(4)

(Total for Question 5 = 8 marks)

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6 Anthropogenic climate change could have caused the warmest years on record in the United Kingdom from 2015 to 2021.

This is leading to changes in the germination of plant seeds.

Some seeds store starch.

(a) Describe the structure of starch.

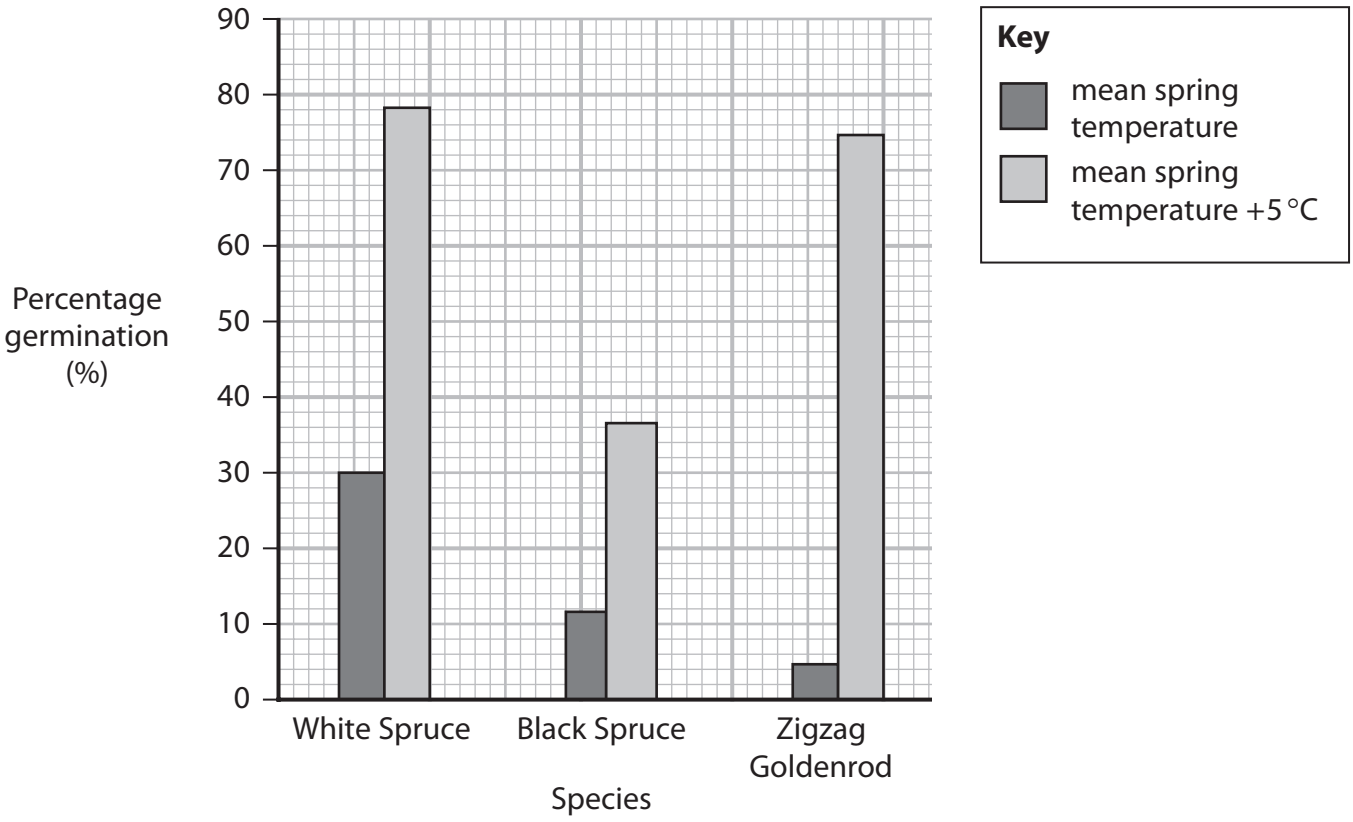
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(b) The starch in seeds is broken down by enzymes during germination.

An investigation into the effect of temperature on germination was carried out using seeds from three species of North American woodland plants.

The percentage germination of these seeds at the mean spring temperature for these woodlands was compared with an increase of 5 °C.



(i) Explain the effect of an increase in temperature on germination of these seeds.

(3)

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(ii) Global warming can result in climate change.

Describe how climate change could affect the distribution of plants in woodlands in North America.

(2)

(c) To conserve plant species, seeds may be stored in seed banks.

Explain why cold and dry conditions are required for the storage of these seeds.

(3)

(Total for Question 6 = 11 marks)

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7 Deer are herbivores living wild and in reserves. Several species of deer can be found in the UK.

Adult deer have no natural predators in the UK, where deer populations are increasing.

(a) (i) A population is a group of individuals

(1)

- ☒ **A** of different species living in the same habitat
- ☒ **B** of one species living in different communities
- ☒ **C** of one species living in different ecosystems
- ☒ **D** of one species living in the same habitat

(ii) In the wild, several species of deer can live in the same area.

Explain why these deer can live in the same area.

(2)

.....

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(b) In one species of deer, a mutation has led to the occurrence of white deer. In some reserves, these white deer have increased in number.

The results of a study of one of these reserves are shown in the table.

Colour of deer	Number of deer
Brown	550
White	250

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(i) The colour of the coats of deer is controlled by a single gene.

The allele for brown coats is dominant and the allele for white coats is recessive.

Calculate the number of heterozygotes in this population using the Hardy–Weinberg equation.

$$p^2 + 2pq + q^2 = 1.0$$

(3)

Answer .....

(ii) It may be beneficial for a population to contain a higher percentage of heterozygote individuals.

Which of the following statements correctly explain why this is the case?

1. Heterozygotes may have an allele which allows for adaptation if conditions change.

2. Heterozygotes reduce genetic diversity.

3. A beneficial allele could be recessive and heterozygotes breeding together may produce a homozygous recessive offspring.

(1)

☒ **A** 1 only

☒ **B** 1 and 2

☒ **C** 1 and 3

☒ **D** 2 and 3

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(c) A study has shown that grazing by deer reduces plant biodiversity in an area.

An area with a large population of deer was compared with an area from which deer were excluded.

Devise a procedure that could be used to measure plant biodiversity in these two areas.

(4)

(Total for Question 7 = 11 marks)

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8 The DNA from skeletons of people living in the UK over the last 4000 years has been studied.

One of the genes studied was the gene for the enzyme lactase.

Lactase is an enzyme that breaks down lactose.

(a) (i) Which of the following statements about the action of lactase is correct?

(1)

- ☒ **A** lactase changes the products of the reaction
- ☒ **B** lactase increases the activation energy of the reaction
- ☒ **C** lactase is used up in the reaction
- ☒ **D** lactase reduces the activation energy of the reaction

(ii) Describe the role of ribosomes in the synthesis of lactase.

(3)

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(b) In most mammals, the production of lactase enzyme decreases when the offspring stop feeding on milk.

In Europe, a single mutation resulted in the continued production of lactase enzyme by children and adults.

The study recorded changes in the frequency of this mutation over the past 4000 years.

Time, years ago	Frequency of mutation allowing lactase production into adulthood	
	UK	Central Europe
4000	0.096	0.079
3000	0.280	0.093
2000	0.680	0.250
1000	0.770	0.590
0 (Present)	0.740	0.440

(i) The frequency of this mutation in Central Europe has increased by 457% in the last 4000 years.

Calculate the percentage increase in the frequency of this mutation in the UK in the last 4000 years.

(2)

.....%

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(ii) During the last 4000 years, changes in farming led to a greater increase in the consumption of milk and dairy products in the UK compared with Central Europe.

Many children and adults in Europe have a mutation that allows continued production of lactase enzyme.

Comment on the effect of consuming milk and dairy products on the change in the frequency of this mutation.

(4)

(Total for Question 8 = 10 marks)

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9 Hepatitis C is a virus that can infect the liver.

In some children, hepatitis C can cause serious liver damage.

(a) After infection with hepatitis C, many people experience a fever.

(i) Explain the role of a fever in the immune response.

(2)

(ii) Individuals infected with hepatitis C produce antibodies.

Describe how the activation of T helper cells leads to the production of antibodies.

(4)

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(b) Hepatitis C enters liver cells and destroys them.

The virus causing hepatitis C has a similar structure to HIV. It is an RNA virus with a lipid envelope and glycoproteins.

Deduce how the hepatitis C virus is able to enter liver cells.

(3)

*(c) Another type of virus that causes liver disease is hepatitis B.

Infection with hepatitis B can be treated with drugs and a vaccine is available.

Treatment		Comment
Drug	Entecavir	Tablet taken daily that inhibits hepatitis B viral polymerase
	Interferon	Weekly injection required
Hepatitis B antibodies		Can be given to newborn babies at risk of infection
Vaccination		Three doses provide long-term protection for 95% of those vaccinated

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Discuss the use of these different hepatitis B treatments.

(6)

(Total for Question 9 = 15 marks)

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10 Resistance of bacteria to antibiotics is an increasing problem.

This has required the development of new antibiotics.

Researchers have developed new antibiotics that are effective against a number of strains of bacteria. They are all bactericidal.

(a) Which of the following statements describes a bactericidal antibiotic?

(1)

- ☒ **A** a substance that can only be used on the skin
- ☒ **B** a substance that kills bacteria
- ☒ **C** a substance that prevents reproduction of bacteria
- ☒ **D** a substance that prevents reproduction of viruses

(b) Two new antibiotics have been developed: antibiotic A and antibiotic B. These were tested against two species of bacteria resistant to the antibiotic ciprofloxacin.

Each species of bacteria (P and Q) was grown in cultures containing:

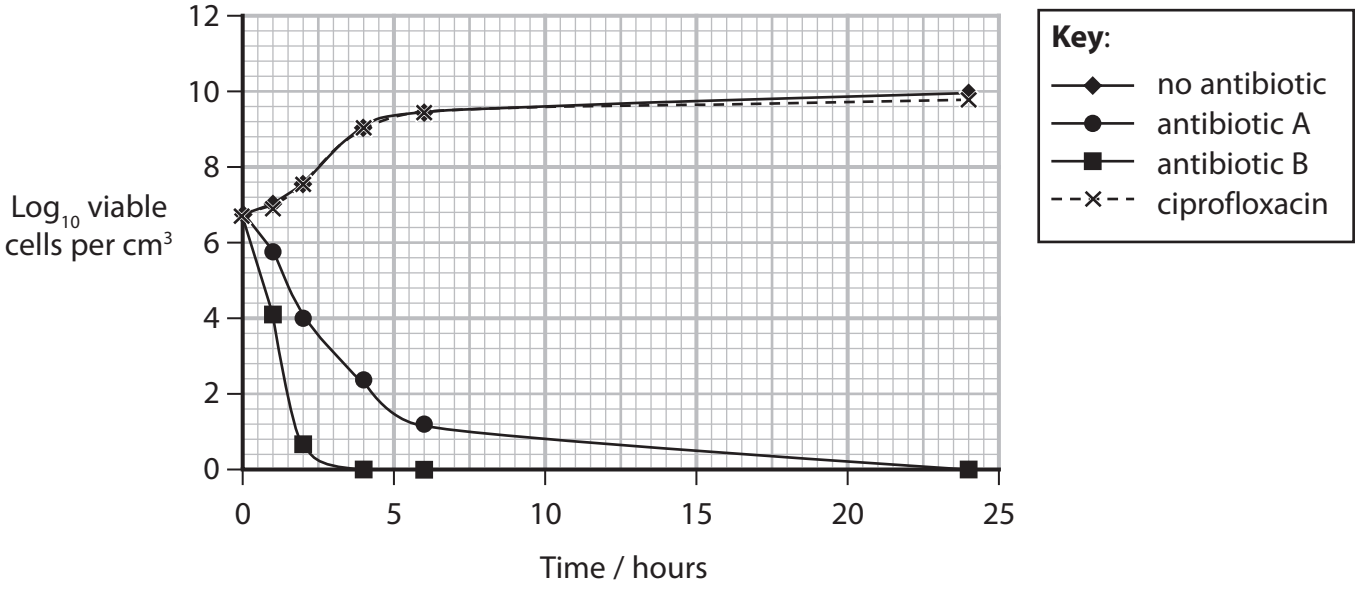
- antibiotic A
- antibiotic B
- ciprofloxacin
- no antibiotic

Each culture was sampled at 0, 1, 2, 4, 6 and 24 hours and the number of viable cells was recorded.

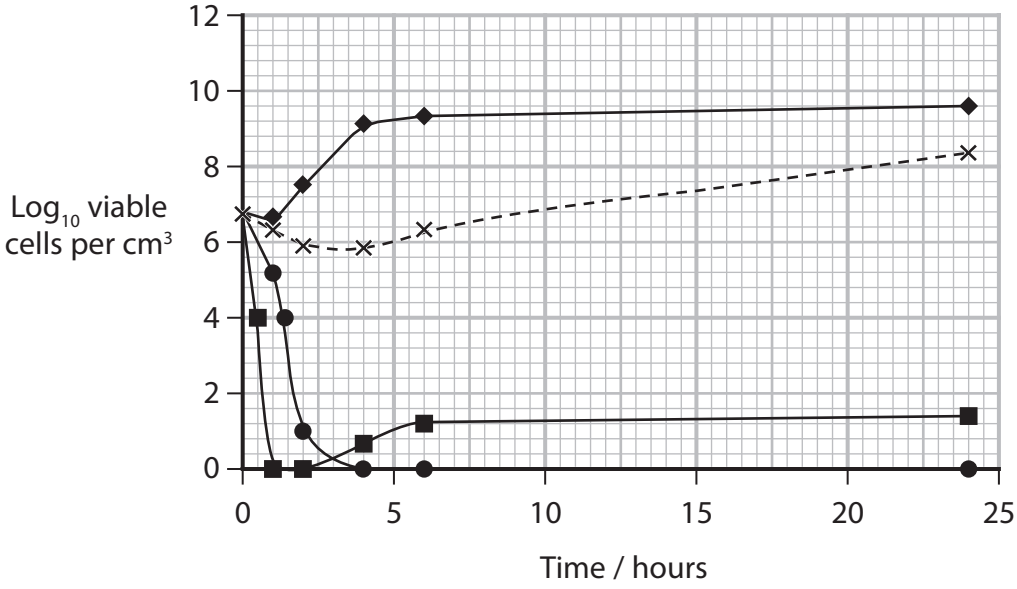
The results of this investigation are shown in the graphs.

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Bacteria species P



Bacteria species Q



(i) Calculate the mean rate of decrease in the number of cells in the first four hours for species P for antibiotic B.

(2)

Answer .....

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(ii) Comment on the effectiveness of antibiotics A and B against both species of bacteria.

(4)

*(iii) A further investigation found the optimum concentration needed to kill bacteria for each of the new antibiotics using cultures on agar plates.

Devise a procedure that could be used to find the optimum concentration for each antibiotic.

(6)

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(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS

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